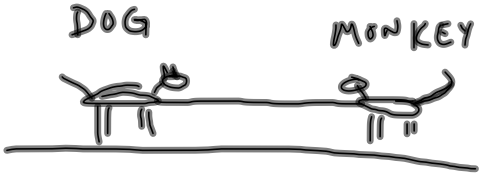
Force Practice Problems 1st Block 9.27.11

A dog (14.0 kg) and a monkey (8.0 kg) are playing tug-of-war on a frictionless surface. They are attached by a rope, and the dog pulls on the monkey's collar with a force of 55.5 N.

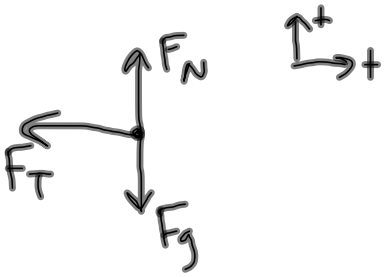
a) What happens to the motion of each animal?
b) Which animal receives the most force?
c) Calculate the acceleration of the monkey.



a) Dog – right
Monkey – left

b) the same

FBD MONKEY



c) $\Sigma F_x = m_m a$

$-F_T = m_m a$

$a = \frac{-F_T}{m_m}$

$= \frac{-55.5\ N}{8.0\ kg}$

$= -6.82\ m/s^2$

"Tug-of-War" Problems

- each object has same force
- if different masses, get different accelerations

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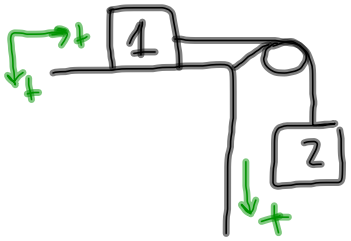
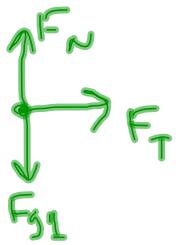
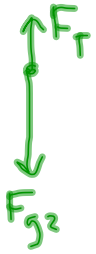
A block of mass 9.89 kg is on a horizontal surface and is attached to a block of mass 5.88 kg that is hanging by means of a rope passed over a pulley. Find the acceleration of the mass on the table.



FBD 1:



FBD 2:



$$\sum \bar{F}_{x1} = m_1 \bar{a} \qquad \sum \bar{F}_{y2} = m_2 \bar{a}$$

$$F_T = m_1 a \qquad F_{g2} - F_T = m_2 a$$

$$m_2 a_g - m_2 a = m_1 a \qquad F_T = F_{g2} - m_2 a$$

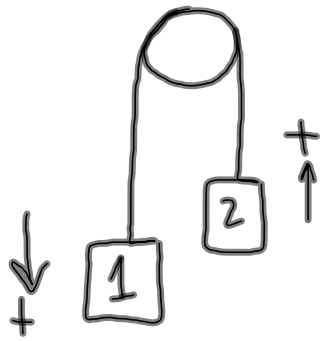
$$a(m_1 + m_2) = m_2 a_g \qquad = m_2 a_g - m_2 a$$

$$a = \frac{m_2 a_g}{(m_1 + m_2)}$$

$$= \frac{(5.88\ kg)(9.8\ m/s^2)}{(9.89\ kg + 5.88\ kg)}$$

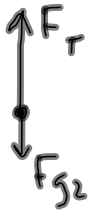
$$= 3.65\ m/s^2$$

Two masses are hanging by a rope passed over a pulley. The mass on the left is 7.89 kg, and the mass on the right is 6.87 kg. What is the acceleration of the block on the right?



FBD 1:

FBD 2:



$\Sigma F_{y2} = m_2 a$ $\quad \Sigma F_{y1} = m_1 a$

$F_{g2} = m_2 g$ $\quad F_T - F_{g2} = m_2 a$ $\quad F_{g1} - F_T = m_1 a$ $\quad F_{g1} = m_1 g$

$m_1 g - m_1 a - m_2 g = m_2 a$ $\quad F_T = m_1 g - m_1 a$

$a(m_1 + m_2) = g(m_1 - m_2)$

$$a = \frac{g(m_1 - m_2)}{(m_1 + m_2)}$$

$$= \frac{(9.8\ m/s^2)(7.89\ kg - 6.87\ kg)}{(7.89\ kg + 6.87\ kg)}$$

$$= .677\ m/s^2$$

Pulley I problem → block table / block hanging
(1) (2)

$$a = \frac{m_2 a_g}{m_1 + m_2}$$ without friction

Eqns. → $\sum F = ma$ $F_g = m a_g$

$F_f = \mu F_N$

Pulley II problem → both masses hanging

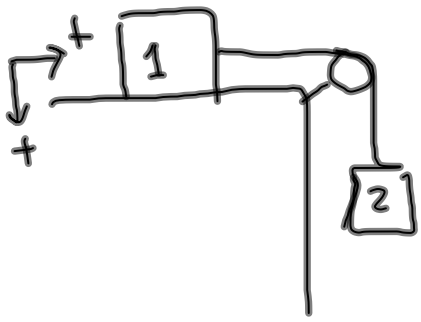
1 → left block
2 → right block

$$a = \frac{a_g (m_1 - m_2)}{m_1 + m_2}$$

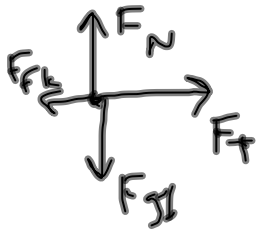
Pulley problems → accelerations are equal

Tug-o-war → force equal

A 12.5 kg block is on a table and is attached by means of a rope and pulley to a 9.55 kg block that is hanging. If the coefficient of friction between the block on the table and the table is 0.678, find the acceleration of the blocks.



FBD 1:



FBD 2:

$\Sigma \bar{F}_{y2} = m_2 \bar{a}$

$F_{g2} - F_T = m_2 a$

$m_2 a_g - (\mu_k m_1 a_g + m_1 a) = m_2 a$

$M_1 a + m_2 a = m_2 a_g - \mu_k m_1 a_g$

$$a = \frac{m_2 a_g - \mu_k m_1 a_s}{m_1 + m_2}$$

$\Sigma \bar{F}_{x1} = m_1 \bar{a}$

$F_T - F_{fk} = m_1 a$

$F_T = \mu_k m_1 a_g + m_1 a$

$F_{fk} = \mu_k F_N$

$= \mu_k m_1 a_g$

$\Sigma \bar{F}_{y1} = 0$

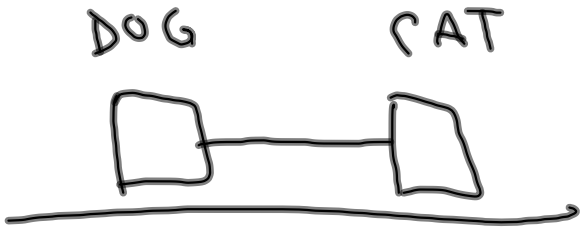
$F_N - F_{g1} = 0$

$F_N = F_{g1} = m_1 a_g$

$$= \frac{(9.55\ kg)(9.8\ m/s^2) - (.678)(12.5\ kg)(9.8\ m/s^2)}{(12.5\ kg + 9.55\ kg)}$$

$= 0.478\ m/s^2$

In a game of tug-o-war on a frictionless surface, a 120.0 N dog pulls on a 65.5 N cat, making the cat accelerate at 1.42 m/s/s. What is the acceleration of the dog?



$m_D = 12.23\,kg \quad m_C = 6.68\,kg$

$F_g = m a_g$

$\sum \vec{F}_C = m_C \vec{a}_C$

$F_T = m_C a_C$

$= (6.68\,kg)(1.42\,m/s^2)$

$= 9.49\,N$

$\sum \vec{F}_D = m_D a_D$

$F_T = m_D a_D$

$a_D = \frac{F_T}{m_D}$

$= \frac{9.49\,N}{12.23\,kg}$

$= .775\,m/s^2$

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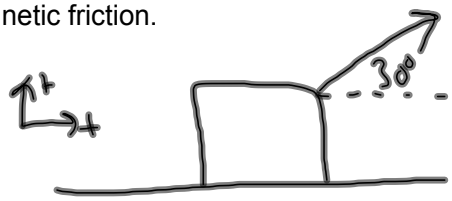
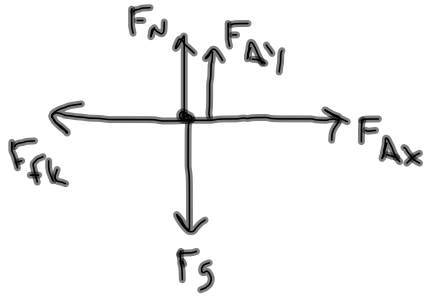
A block with mass 20 kg is pulled along a horizontal surface at constant velocity with a force of 100 N at an angle of 30 degrees above the horizontal. Find the coefficient of kinetic friction.





(1) $F_{fk} = \mu_k F_N$

$\mu_k = \dfrac{F_{fk}}{F_N}$

(2) $\sum F_x = 0$

$F_{Ax} - F_{fk} = 0$

$F_{fk} = F_{Ax} = F_A \cos(30°)$

$= (100\ N)\cos(30°)$

$= 86.6\ N$

(3) $\sum F_y = 0$

$F_N + F_{Ay} - F_g = 0$

$F_N = F_g - F_{Ay}$

$= mg - F_A \sin(30°)$

$= (20\ kg)(9.8\ m/s^2) - (100\ N)\sin(30°)$

$= 146\ N$

(4) $= \dfrac{86.6\ N}{146\ N}$

$= 0.593$